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OPERATIONAL ISSUES WITH IMPULSE DRYING SLUDGE

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ABSTRACT

Impulse drying technology can be applied to most primary and mixed primary/secondary cakes from pulp and paper operations. Results from the first two onsite trials illustrate some of the factors that govern dewatering include belt porosity, roll temperature, pressure, belt cleaning, ash content, sludge feed delivery, and sludge structure and type. Roll sticking is one of the most important determining factors governing universal application of the technology. The potential for roll sticking cannot presently be evaluated *a priori*. Refinements made in the unit as a result of these trials are discussed.

KEYWORDS

belt, heat, sticking, solids, steel, induction, carbon.

INTRODUCTION

The impulse drying process involves passing pressed cake through a nip arrangement with a heated top roll. The vapor pressure generated at the roll-sheet interface opens the cake web and expels filtrate in liquid form. Laboratory work conducted with a simulated impulse dryer with a wide variety of sludges, showed that more than twenty percentage points of water could be removed from sludges with an incoming solids content of 25-30% (Banerjee et al. 1998). Subsequent pilot work conducted with two primary cakes confirmed the high dewatering potential available from the technology (Mahmood et al. 1998). Ashbrook Corporation, Houston, TX, has built a 1-meter press, which has been used with several primary and mixed primary/secondary sludges. Some of the operational parameters that both enhance and limit the technology are described in this paper. In particular, results from two early trials are discussed along with the improvements made to the process as a result.

MATERIALS AND METHODS

Description of the unit

The 1-meter impulse dryer, illustrated in Figure 1, is approximately 3.3 x 5.4 meters and weighs approximately 11.5 tons. An illustration of the roll surface during operations is shown in Figure 2. A three phase, 480 volt, 60Hz power supply is required. The top roll is heated by a 100 kW induction heater supplied by TOCCO. Clean water is used for belt washing and inductor cooling. Pressed sludge is conveyed through the machine on either a porous polyester or a stainless steel belt. A brass doctor blade located just after the nip cleans the upper roller. Pressures of up to

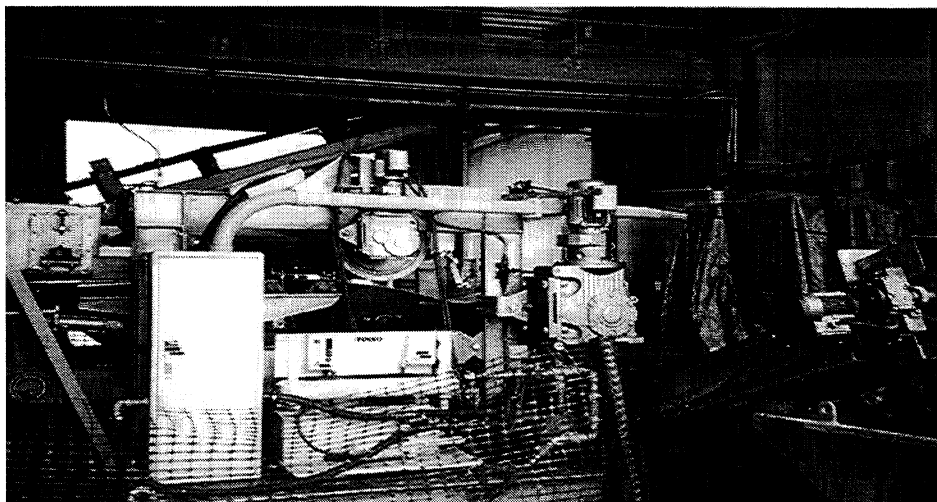


Figure 1: Illustration of the impulse dryer.

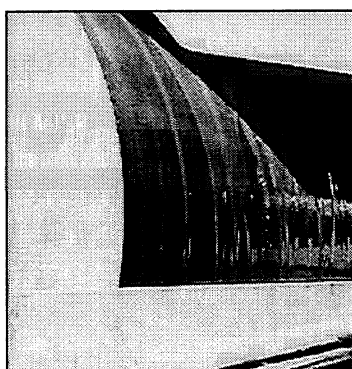


Figure 2: Illustration of the roll surface during impulse drying.

1,000 psi can be applied to the hydraulic cylinders lifting the lower roller, giving a maximum nip pressure of 1,500 pli. The sludge is applied to the belt through an auger box, and an even layer is delivered to the nip via a tapered spreader plate. The belt is washed with a high-pressure water curtain.

Trials at Washburn

Initial shakedown trials were run in May/June 1998 at Gulf Coast Authorities' Washburn Tunnel facility in Pasadena TX. The sludge composition was 70% primary waste, and 30% secondary material. The major industrial component originated from an adjacent paper mill, although several oil related industries and the local municipality also discharge to the plant. Final belt filter pressed cake was used as feed for

the impulse dryer trial. Several belts were initially screened. Polyester belts worked well, but could not be used routinely since they scorched when intermittent contact inadvertently occurred with the hot upper roll. The problem was circumvented with metal belts, but weave style was critical. Belt plugging occurred quite rapidly with loosely woven belts, and permeability could not be restored even with the high-pressure wash. The problem was largely removed with a tightly woven belt; at present, a stainless steel belt from National Filtration is being used. Surface deposition occurred even with this belt at higher nip pressures, but additional cleaning was achieved with a counter-rotating scrubber brush mounted against the belt.

The rig was located within the belt press house for the duration of the trial. It was not possible to feed the unit directly from the belt presses or from the discharge conveyors, so dry cake was provided by filling up a large steel container, and shoveling the material into the impulse feed box. The treated cake was collected in another steel box located under the impulse discharge conveyor. The feed container was filled either from the truck loading facility or directly out of the

back of one of the facility's trucks. The sludge fed to the impulse dryer consisted of pieces of cake of up to one inch long, which passed easily through the spreader box and onto the feed belt.

Trials at Virginia

The mill produces linerboard and utilizes a small amount of recycled fiber. An Ashbrook belt filter press was used onsite to provide pressed cake for the impulse dryer, as this facilitated full control over feed rates and polymer dosing. One inlet feed to the belt filter press was hooked up to the blend tank that fed the screw press units operational at the mill. The composition of the sludge from the blend tank was approximately 70/30 primary/secondary by weight. The second inlet to the belt press was attached to a sludge outlet from the secondary clarifiers and provided 100% secondary sludge. The overall composition of the pressed cake could be varied by adjusting the two feeds. Grab samples were taken and analyzed for feed and treated percentage dry solids and filtrate TSS. The cake produced by the belt filter press was difficult to break up due to the high fiber content and would not pass under the wedge plate before the impulse dryer rollers. Hence, the spreader plate had to be removed, and the thickness of the cake feed was uncontrolled.

The mill typically uses Nalco 7193 polymer at 15 lb/ton to treat the material fed to the screw presses. The belt press used in the trial utilized the same polymer but with an average dose of 2 lb/ton. Both sludges were passed through the impulse rig and the performance assessed. Nalco 7192 was used to treat the secondary waste and was fed to the belt press for a short period to determine the results on the 70/30 blend from the impulse dryer.

RESULTS

The raw sludge differed greatly between the two sites as was evident by the need to remove the spreader plate at Virginia, where the sludge had a higher fiber content. The Washburn sludge was slightly darker in color with a distinctive odor, and did not possess the same mechanical strength. The average dry solids for both the Washburn and Virginia feed was 33%. The ash content was 32.9% at Washburn, and 10.5% at Virginia.

Effect of pressure

The impulse dryer at Washburn was initially set up to match laboratory results that showed that best performance could be expected at a temperature of 288°C with as high a nip pressure as possible. The majority of the testing conducted at Washburn was carried out at fixed process parameters since mechanical issues such as cake distribution and belt cleaning were of primary concern at this point in the study. The pressure applied to the sludge is dependent on the hydraulic pressure applied to the cylinders, the geometry of the machine, and the width and thickness of the sludge treated. The pressures quoted in this report are those applied to the hydraulic cylinders. The relationship between pressure and dry solids is illustrated in Figure 3 for the Washburn study. Figure 4 shows the effect of increasing the pressure on the Virginia cake. A problem with passing the material through the rollers was encountered, and the belt began to slip at pressures exceeding 250 psi. This was primarily due to the lack of control of the feed consistency and thickness with this high fiber material. Slipping became the critical issue since pressures of over

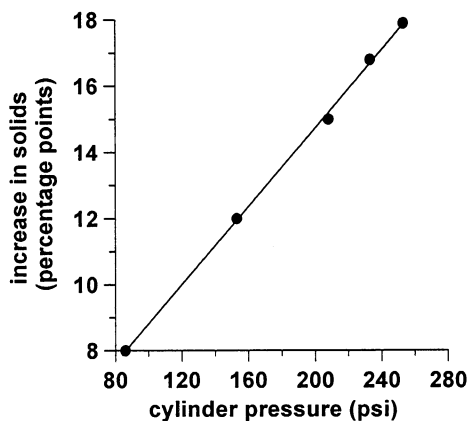


Figure 3: Effect of nip pressure on Washburn sludge (belt speed: 2 meters/minute; polyester belt; 287°C)

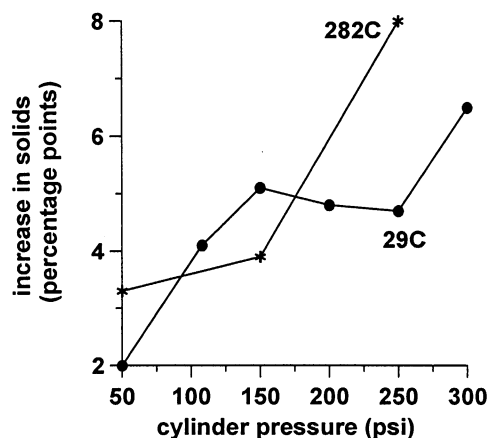


Figure 4: Effect of nip pressure on Virginia sludge (belt speed: 2.3 meters/minute; polyester belt)

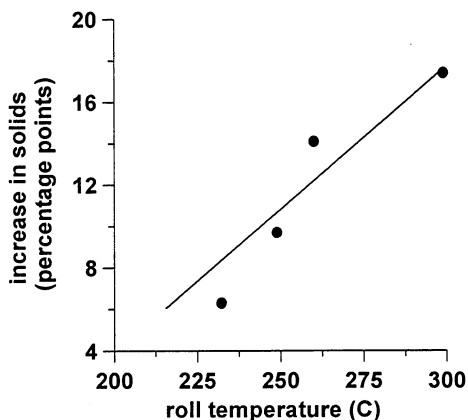


Figure 5: Effect of temperature on Washburn sludge (belt speed: 2 meters/minute; stainless steel belt; 90 psi peak pressure).

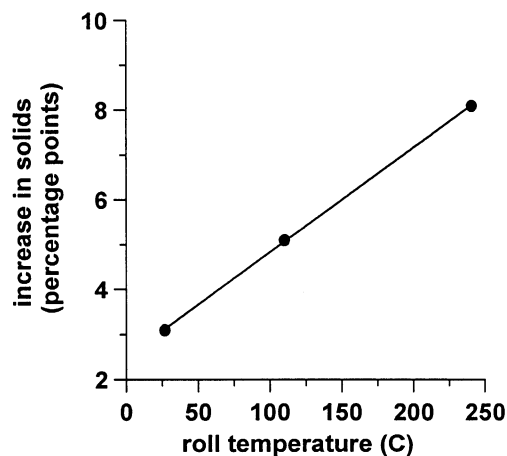


Figure 6: Effect of temperature on Virginia sludge (belt speed: 2.2 meters/minute; polyester belt; 200 psi peak pressure).

250 psi could be applied without belt blinding. When the composition of secondary material was increased, the pressure that could be applied to the sludge without belt blinding was dramatically reduced. A 60:40 ratio of primary to secondary sludge dropped the permissible applied pressure to less than 20 psi. The composition of the Washburn sludge varied over the course of the trial, and generally the pressure that could be applied to the sludge was less than that for the Virginia study and was related to the quantity of secondary material. Although the applied pressures were lower, the dewatering performance was better than that obtained at Virginia.

Table 1: Energy considerations at Washburn and Virginia			
	throughput (dry tons/hr)	average increase in dry solids	energy KWH/ton
Washburn	0.343	9.6 - 17 %	204
Virginia	0.319	4.5 - 8 %	172

Effect of temperature

Laboratory work suggested that increasing temperature beyond a certain point only evaporates liquid from the cake and does not aid in the impulse process. Initial testing at Washburn began with a roll temperature of 288°C since belt blinding occurred in the laboratory when cake was processed with a cold roll. The dry solids at Washburn increased with roller temperature as shown in Figure 5. At temperatures below 232°C, the sludge began to stick to the upper roller and passed under the inductor. This became a hazard as the material could potentially ignite. This problem was not seen at temperatures above 232°C.

The effect of upper roller temperature on dry solids results for the Virginia cake can be seen in Figure 6. The impulse dewatering performance is substantially lower than that observed at Washburn. Roll sticking occurred over a wider temperature range of 100 to 316°C. Sticking ceased beyond 316°C and the roller remained relatively clean. Below 316°C, the scraper system was ineffective as the cake seared to the surface of the upper roll. This sticking was not caused by constituents sent from the recycling plant since the problem continued even when this flow was down. Most of the data were collected at Virginia with the heated roller at a temperature above 316°C to prevent this problem. It is inefficient to heat the roll to prevent cake sticking unless this also benefits dewatering as the higher temperature demands a higher energy input. When the spreader plate was removed, the material bunched up before the hot roller. This was detrimental in that heat was transferred from the roller to the cake before the pressure was applied; i.e., the sludge was being heated without any gain in process performance.

Energy Consumption

The impulse dryer was fitted with a stainless steel roller during both trials. A carbon steel roll will increase inductor efficiency by up to 30%. No shielding or insulation was included on the prototype machine, so additional energy savings could be designed into the machine. During the Washburn trial, the maximum continuous feed period was 45 minutes, which was too short a period for adjustments to be made to stabilize temperature. Hence, the energy estimates provided in Table 1 are only approximate.

DISCUSSION

Only minor modifications were made to the impulse dryer in between the Washburn and Virginia trials. Similar temperatures, pressures and belt speeds were used at both sites, and cake of similar thickness was produced at the higher pressures. Apart from the absence of the spreader plate at Virginia, there was no change in setup of the impulse dryer between the two sites. Nevertheless, significantly higher dry solids were obtained at Washburn.

The major difference between the two trials was the cake fed to the impulse system, which was very different in both nature and composition. The Washburn cake had a high ash content and resisted compression when pressed. The Virginia sludge was lower in ash but was of higher mechanical strength. This sludge withstood a higher pressure when passed through the nip without sticking to the belt. The two sludges started sticking to the upper roll at different temperatures and produced different types of filtrates. It is not presently possible to identify the constituents in sludge that determine the effectiveness of application. With continued testing, it should be possible to tie sludge characteristics to sludge.

Several modifications to the system have been effected after the initial trials. The upper roller was changed to a carbon steel design to increase energy efficiency, and the angle of the scraper blade has been adjusted to enable more efficient cleaning of the upper roller. As the feed to the system appears to be critical, the whole auger box was redesigned to improve the current feed system. The ideal situation would be direct feed from a belt filter press as a continuous sheet. Without operating the unit on a continuous basis, it is not possible to determine the full impact of changing the upper roll composition. Batch testing with the unit has indicated no change in sticking properties of the roll, but the initial heating of the roll is faster. The scraper now works more efficiently because of the adjustments. The new cake breaker design produced an exceptionally fine feed to the nip rollers. Although the results were good with this consistency, the throughput was low, and the unit had to be redesigned. The current setup produces a coarser cake consistency and is awaiting full-scale testing.

CONCLUSIONS

The impulse dryer can produce exceptional results as indicated by the Washburn data which demonstrate the commercial viability of the process and illustrate the huge potential of the technology. As with the initial testing of any new product, the window of application is unknown so this level of performance may be applicable to certain sludge types only. From laboratory bench tests it is estimated that the technology should apply to about 90% of paper mill sludges. The Virginia sludge was more difficult to treat than the Washburn material, and this was also suggested by work at the Institute. Currently, it is not possible to project, *a priori*, which sludges will be compatible with the impulse technique.

ACKNOWLEDGMENTS

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